Space Weather Technical Forecast

Issued on Wednesday, 15 December 2021 at 12:01 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor Geomagnetic Storms day 1 (15th). Potentially increasing solar activity.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity was Low, with multiple C-class flares in the past 12 hours, mainly from 2907. The largest of these was a C8.1 flare at 15/1044UTC.

There are currently four numbered and two un-numbered sunspot regions on the visible disc. Most notably AR2907 in the southeast quadrant has continued to grow in size and complexity, and has a delta spot configuration evident in the main central portion. The region is currently classified as Dac/Beta-gamma-delta. AR2906 (Cao/Beta), again in the southeast, has shown slight growth in its lead penumbra. AR2905, the western-most group in the southeast, continues to fade, now a Axx/Alpha group.

There are two further sunspot regions toward the southeast limb. The western-most region has now been numbered 2908 and emerged rather quickly, currently a Dao/Beta type. The region closest to the southeast limb appears to have a similar spot configuration, although more stable in growth, and is un-numbered at present. However, both these regions are still difficult to fully analyse due to foreshortening effects.

There is also one other newly emerged small spot group approaching centre disc in the northeast quadrant, Bxo/Beta.

A filament eruption from around N45W05 was observed at 14/1200 UTC and a faint slow, narrow CME is evident in STEREO A imagery. This may have an Earth-directed component, with further analysis still pending. However, no significant impacts are expected at this time. Otherwise no other potential Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured at L1, was at background levels for much of the period, 310-350 km/s. However, after 15/0300UTC speeds increased steadily to reach current values around 550km/s, this was due to the connection to the fast wind from coronal hole 32. Density was mainly above average, peaking at around 31ppcc just prior to the connection with CH32. The Interplanetary Magnetic Field strength (IMF) Bt was weak but again rose to a peak near 16nT, as the high speed stream arrived. It has now returned to mostly weak levels, around 8nT. A similar trend was observed with the Bz component, peak +14nT to -15nT around the high speed stream arrival time. The Phi angle was initially positive (away from the sun) but switched to negative (towards the sun) from 14/1830 UTC. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels. The high energy electron flux (greater than 2 MeV) was at mainly Background levels with the associated 24-hour integrated fluence well below the Active threshold. Fluence of 1.52e6 was observed at 15/0000 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be mainly Low, but with a chance of M-class flares and a very slight chance of X-class flares given the recently developing and increasing numbers of sunspot regions on the visible disc. Further sunspot regions may rotate onto the visible disc in the coming days to supplement the current risk of significant flares.

Solar Wind / Geomagnetic Activity: Solar winds are now at elevated levels following connection with coronal hole 32 early on day 1 (15th). Winds should gradually ease later day 2 (16th) and eventually back to slightly elevated or background by the end of day 4 (18th). No further coronal hole enhancements are anticipated during the period. Geomagnetic activity is expected to be Unsettled or Active initially on day 1, with a slight chance (20%) of a G1/Minor Storm. Geomagnetic activity will wane again after the peak period of fast wind into days 2 and 3 (16th and 17th) with Quiet conditions predominant.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels, although with a slight increasing risk of enhancement with time due to developing sunspot activity. The high energy electron flux (greater than 2 MeV) is expected to be Background to Moderate levels initially. The arrival of the fast wind from a coronal hole on day 1 (15th), has the potential to increase the flux by day 2 or 3 (16th or 17th) with persistently High flux possible by late day 2 or day 3 and perhaps also day 4 (17th), although confidence remains Low for this. The associated 24 hour fluence is expected to persist well below the Active level on day 1, with a slight, but increasing chance of rising above by the end of day 3 and continuing into day 4.

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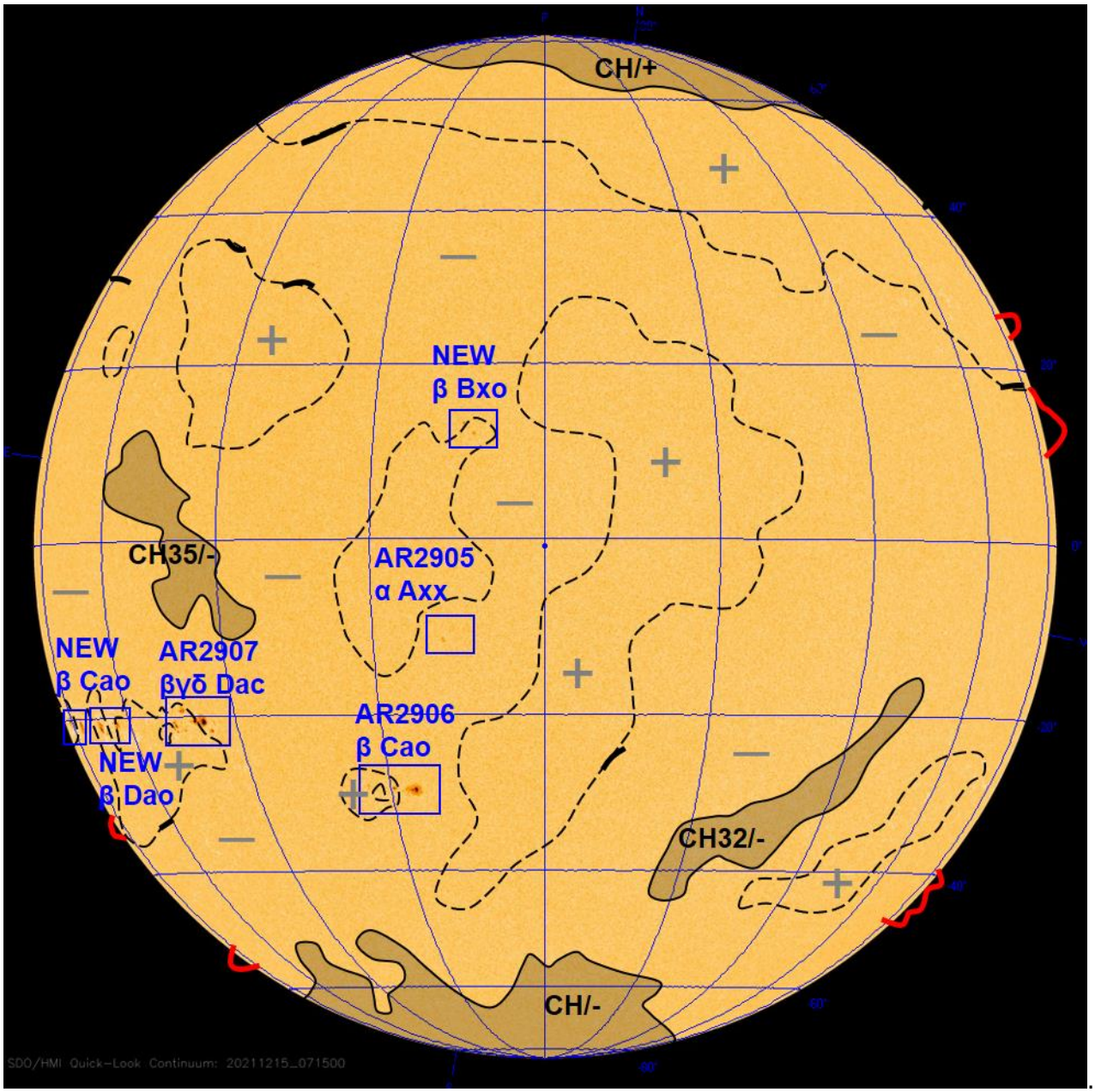
Figure 1. Solar Analysis Valid 15/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption from around N45W05 was observed at 14/1200 UTC and a slow CME is evident in STEREO A imagery. This may have an Earth-directed component, with further analysis still pending. However, no significant impacts are expected at this time. Otherwise no other potential Earth-directed CMEs have been observed.
Connection with coronal hole 32 was been established in the early hours UTC of day 1 (15th) with elevated winds of around 550 km/s at present. Solar wind speeds should gradually ease by later day 2 (16th) and eventually back to slightly elevated or background by the end of day 4 (18th). This is supported by Enlil, which has an enhancement occurring early on day 1. No further coronal hole enhancements are anticipated during the period.

Geomagnetic activity is expected to be Unsettled or Active initially on day 1, with a slight chance (20%) of a G1/Minor Storm. Geomagnetic activity will wane again after the peak period of fast wind into days 2 and 3 (16th and 17th) with Quiet conditions predominant.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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Radio Blackouts - X-Ray Flares:

There are currently four numbered and two un-numbered sunspot regions on the visible disc. Most notably AR2907 in the southeast quadrant has continued to grow in size and complexity, and has produced multiple C-class flares in the past 12 hours. The largest of these a C8.1 flare at 15/1044UTC. A delta spot configuration is evident in the main central portion. The region is currently classified as Dac/Beta-gamma-delta. AR2906 (Cao/Beta), again in the southeast, has shown slight growth in its lead penumbra. AR2905, the western-most group in the southeast, continues to fade, now a Axx/Alpha group.

There are two further sunspot regions toward the southeast limb. The western-most region has now been numbered 2908 and emerged rather quickly, currently a Dao/Beta type. The region closest to the southeast limb appears to have a similar spot configuration, although more stable in growth, and is un-numbered at present. However, both these regions are still difficult to fully analyse due to foreshortening effects. There is also one other newly emerged small spot group approaching centre disc in the northeast quadrant, Bxo/Beta.

The cluster of sunspot regions in the southeast quarter will be closely monitored over the coming days. For now mainly Low activity is expected with a 35% chance of M-class and 5% risk of X-class flares given the current configuration of sunspots on the visible disc. Further active regions are likely to rotate into view over the next week as suggested from the side-view of the Sun provided by STEREO A.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	35	35	35	35
Very Active	R3 to R5 X Class	No	5	5	5	5

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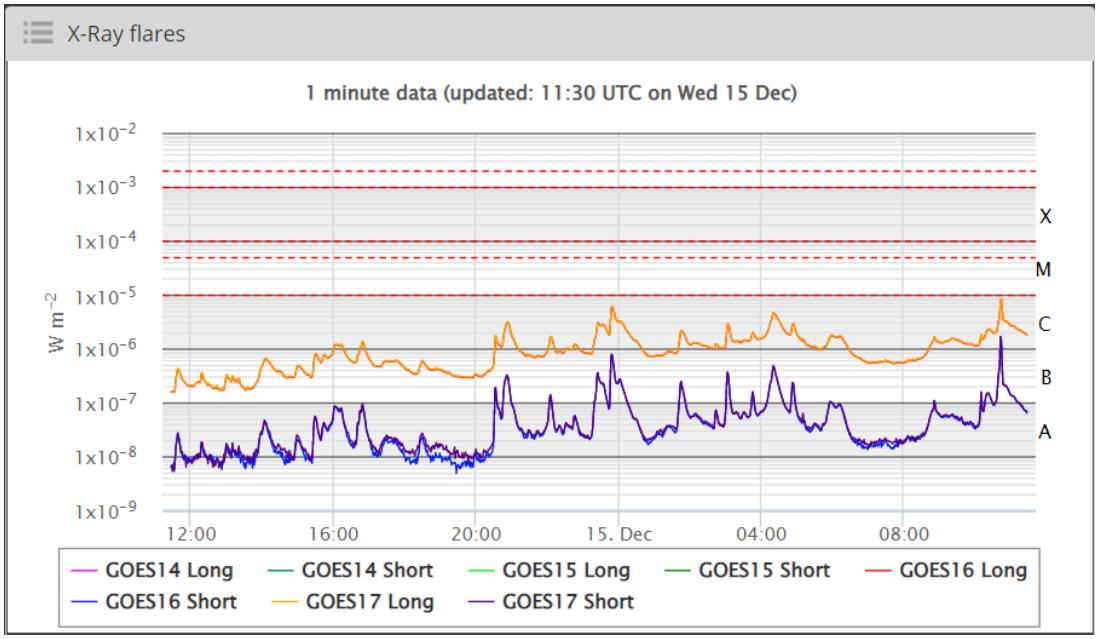
Figure 2: GOES X-ray flux showing recent C-class flare activity.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels. Increasing sunspot activity may warrant a slight increase of chance of S1 over the next few days, but as the regions are in the east quadrant of the solar disc, any large flares are less likely to affect the Earth. They will become more of a risk when they move into the western quadrant if they are still active.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	3	3	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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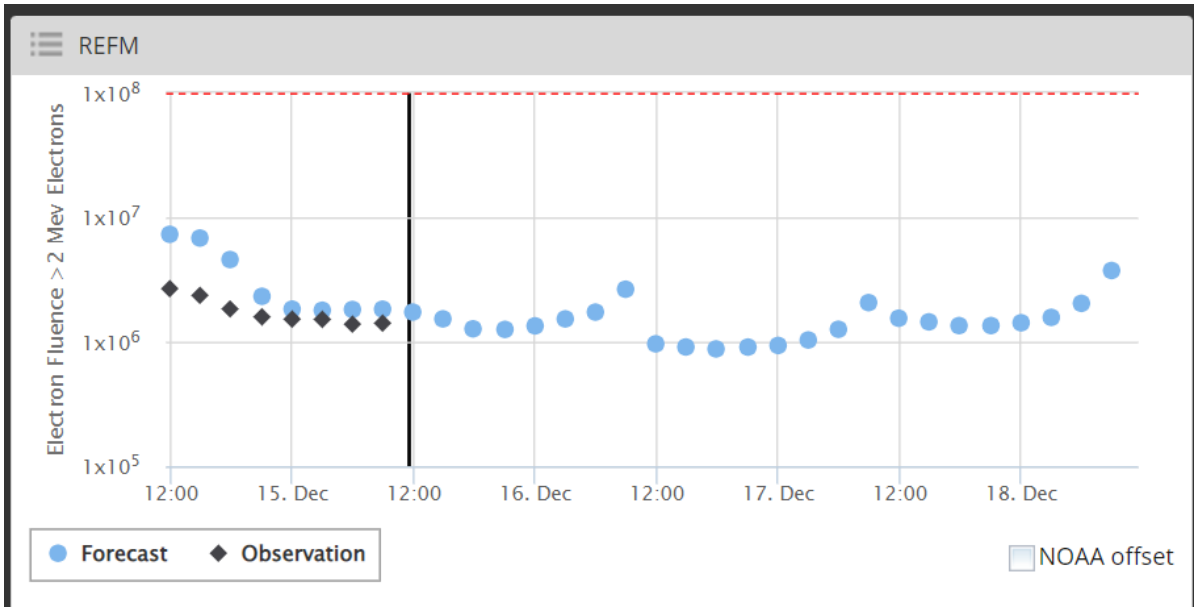
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as observed by GOES-16, is expected to be at Background to Moderate levels initially. The arrival of the fast wind of coronal hole 32 on day 1 (15th), has the potential to increase the flux by day 2 or 3 (16th or 17th) with persistently High flux possible by late day 2 or day 3 and perhaps also day 4 (17th), although confidence remains Low for this.

The associated 24 hour fluence is expected to persist well below the Active level on day 1, with a slight, but increasing chance of rising above by the end of day 3 and continuing into day 4. This is supported by REFM which maintains fluence below the Active threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM.



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